



Lesson Plan

Grade/Subject

6th Science

9th Earth Space Science

Core: 6.2.1 & ESS 4.1

Title

Smoke in a Bottle:

Complete vs Incomplete Combustion

Standard/Objective

6.2.1 Develop models to show that molecules are made of different kinds, proportions and quantities of atoms. Emphasize understanding that there are differences between atoms and molecules, and that certain combinations of atoms form specific molecules. Examples of simple molecules could include water (H₂O), atmospheric oxygen (O₂), and carbon dioxide (CO₂). (PS1.A)

ESS 4.1 Construct an explanation for how the availability of natural resources, the occurrence of natural hazards, and changes in climate affect human activity. Examples of natural resources could include access to fresh water, clean air, or regions of fertile soils. Examples of factors that affect human activity could include that rising sea levels cause humans to move farther from the coast, or that humans build railroads to transport mineral resources from one location to another. (ESS3.A, ESS3.B)

Lesson Performance Expectations (description):

Students ask questions and analyze data related to the use of wood, a solid fuel, compared to gas fuel or renewable energy sources such as solar or wind. Cause and effect of the combustion of various fuels will be compared.

Materials: heavy 20 mL clear plastic water bottle (Smart water bottle works well) #4 one-hole stopper, 1 glass dropper tube, paper toweling, canister of propane and self-starting torch head (video), hand lens.

Drill to put hole in the bottle near the bottom OR hot nail to make the hole. Put Duct tape over the hole

[Combustion ppt](#)

[Air Aware ppt](#)

[Wood combustion video](#)

[Complete Combustion of propane](#)

[Drives Education Video](#)

Time: 2 50 minute periods

Teacher Background Information:

[Video of the smoke in a bottle demo](#)

Student Background:

Students should understand that air is composed of different gases and that gases and particles (solids) are given off when things burn.

Teacher Step by Step

Phenomenon: *Observation of event, data or other evidence of activity.*

Show this video comparing a propane torch burning to a piece of paper.

Incomplete Combustion using paper as fuel. [Incomplete Combustion - Paer.mp4](#)

Complete Combustion using Propane as fuel [Complete Combustion - Propane.mp4](#)

Ask students to explain the phenomenon but do not explain it yourself. Questions they may ask and will be used in the activity: Where does the paper (propane) go? Is it all gone? What is the smoke made of? Does all of the fuel burn? What color are the flames? Why does the paper curl? Does wood burn like the paper does?

- A. Students start to fill out the worksheet.
 - a. Show the students the demonstration of Smoke in a Bottle. Put tape over the hole and fill the bottle with water. Role a small piece of paper and insert into the dropper. Put the dropper in the stopper and the stopper into the bottle. Light the paper on fire and pull off the tape. As the water drains out the smoke will be drawn into the bottle. Take off the stopper and cover the opening with multiple layers of paper towel and secure with a rubber band. Use the bulb syringe to push the air out of the bottle from the hole at the bottle. The soot will accumulate on the inside of the paper towel. Pass around the paper towel with a hand lens to see.
- B. Show the Powerpoint on [Combustion](#) and answer questions on the worksheet.
- C. Show the video [Know When To Burn](#)
- D. [Science Spotlight: The Combustion of Wood](#) (1:26 minutes)
- E. Show the Air Aware [Powerpoint](#) and answer questions on the worksheet.

Teacher Resources:

1. [Criteria Air Pollutants](#)
2. [Major Air Pollutants](#)
3. [6 Common Types of Air Pollution](#)
4. [UCAIR: Home](#)
5. [Breathe Utah - Home](#)

Assessment of Student Learning.

1. What is necessary for combustion to occur? Choose three.
 - a. Carbon
 - b. Fuel*
 - c. Gases
 - d. Heat*
 - e. Oxygen*
 - f. Solids
2. What evidence shows incomplete combustion? Choose all that apply.
 - a. Smoke*
 - b. Blue flame

- c. Leftover ash*
- d. Extra heat produced
- e. Heat spreads away from source

2. When do substances burn most completely?

- a. When they create carbon dioxide.
- b. When they are in a small container.
- c. When they are made of wood substances.
- d. When they have maximum surface area exposed.*

3. Most fuels are composed of carbon and hydrogen molecules. What substances are produced by combustion? Choose all that apply.

- a. Water (H₂O)*
- b. Hydrogen (H₂)
- c. Carbon dioxide (CO₂)*
- d. Oxygen (O₂)
- e.)Natural gas (CH₄)

4. The brown tar left by the smoke passing through a paper towel is evidence of what process?

- a. Fuel absorption
- b. Nitrogen creation
- c. Water vaporization
- d. Incomplete combustion*

5. Why is wood burning in household fireplaces often prohibited during the winter months in Utah?

- a. To preserve forests.
- b. To reduce pollution.*
- c. To allow storms to clear the air in valleys.
- d. To keep houses from losing heat out of the chimney.

6. Why are PM2.5 particles the most hazardous to human health?

- a. They lodge on the skin and block blood vessels.
- b. They are nearly twice as large as other particles.
- c. They cannot be seen or measured by instruments.
- d. They are absorbed into the lungs and bloodstream.*

Extension:

Students can research the existing Utah regulations on wood burning. Students can write a bill addressing the issue of wood burning. Students can write an argument with evidence on the question of whether fines are useful for getting people to follow the law.



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Title: Smoke in a Bottle

Name _____

Phenomenon: Watch as a piece of paper is burned and the flame of a propane tank. Ask three questions about these processes:

- 1.
- 2.
- 3.

Draw what was happening to the fuel particles in each case. Label as needed.

Paper	propane
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Watch the “Smoke in a Bottle” demonstration and start with a prediction. Ask three questions about this process:

- 1.
- 2.

3.

Directions:

1. Watch the powerpoint on combustion. Answer the questions that you now have information for.

2. If you have unanswered questions, talk to another student in your class and see if they know the answer. If not, go to #4.

3. Use a computer to find the answer to your question that was unanswered.

4. Watch the video . [Science Spotlight: The Combustion of Wood](#)

Explain what happened using these words; complete and incomplete combustion.

Redraw. Label with oxygen, carbon dioxide, and water. Show unburned substances. Use arrows if needed.

paper	propane
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5. How did the products of combustion vary between the propane and the paper?

Watch the "Air Aware PPT

6. Wood burning stoves in homes are banned during certain days of the year, usually in winter. Why?

7. How and when does an inversion or "cold air pool" develop?

8. Why are PM 2.5 particles hazardous to humans?

9. What are three ways people contribute to poor air quality?

10. What are three things you can do to reduce air pollution?

